Remarks/Arguments

This Reply is timely filed and responsive to an Office Action mailed June 09, 2003.

In the Office Action, claims 1-12, 14-21 and 23-41 were rejected. Claims 13 and 22 were objected to, but were determined to be allowable if written in independent form including all limitations of their respective independent claims and any intervening dependent claims.

In this Reply, claims 1, 3, 9, 13, 15, 19-21, 30 and 33 have been amended. Claims 2, 5, 6, 18, 28, 29, 31 and 32 have been cancelled. No new matter has been added.

The Drawings were objected to by the Examiner as not showing the emitter recited in claim 2, the feedback and control system for modifying at least one dimension of a flow channel recited in claim 9, the nebulizer of claim 5, the voltage divider of claim 22, the mass spectrometer of claim 30, and the electrochemical cell of claim 31. In response, claims 2, 5 and 31 have been cancelled. Figure 1(b) has been amended to now show a mass spectrometer along with the amended paragraph beginning on page 15, line 6 which describes the same. Figure 2(b) has been amended to add a voltage divider along with the amended paragraph beginning on page 21, line 3 to describe the same. Figure 1(b) has also been amended to a control system that adjusts chamber dimensions in response to a measured parameter, such as analyte current measured at the mass spectrometry 190, along with the amended paragraph beginning on page 19, line 13. Accordingly, the objections to the drawings are now overcome.

The Examiner rejected claims 7-9, 23, 35, and 37-40 under 35 U.S.C. §112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claim 7 recites "at least one dimension of said flow channel is modifiable" and claim 8 recites that the modifiable dimension is "said fluid height". Applicant respectfully disagrees with the Examiner's determination that claims 7 and 8 fail to satisfy 35 U.S.C. §112, first paragraph. Applicant has copied page 25 line 15 to page 26, line 9 from the specification which clearly explains this important feature using the multi-member chamber removably secured together using easily removable turn screw fasteners:

> Electrode support member 320 is preferably held against capping member 340, separated by flow member 335 (e.g. spacer gasket), by at least one fastener (not shown). The fasteners can be inserted through members 320, 335 and 340 using holes 151-154 to align and compress the respective members together. In the preferred embodiment, the fasteners used are turn screws. For example, approximately one turn of the screw counter clockwise can permit removal of the electrode support member 320. This fitting system is available from Bioanalytical Systems, Inc. 2701 Kent Avenue West Lafayette, IN 47906, which uses these fasteners on thin-layer electrochemical cells used as detectors for liquid chromatography. The ability to quickly and easily disassemble and reassemble the electrode chamber 310 allows for the electrode area, electrode material, and channel height 108 to be rapidly and conveniently modified.
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> Using the turn screw fasteners described, electrode support member 320 is easily removable. One can remove electrode support member 320 including working electrode 102 and replace it with another electrode support member 320, such as one having a different electrode material or different electrode area. The effective electrode size and shape can be varied by either changing the physical size or shape of the electrode 102 or by changing the shape of the void region 336 in fluid member 335 (e.g. spacing gasket).

For example, a thicker fluid member 335 (e.g. spacing gasket) can replace a thinner fluid member 335 to increase the channel height 108, which is what is recited in claim 8 as "said fluid height." See also page 22, line 16 to 20 which describes changing the fluid height over the working electrode using the modifiable thickness of the spacing gasket 335. In view of the above, Applicant submits that the 35 U.S.C. §112, first paragraph rejection of claims 7 and 8 should be removed.

Claim 9 recites "a feedback and control system for modifying at least one dimension of said flow channel based on at least one measurement derived from said fluid transmitted from said chamber ". According to page 19, lines 6-19 upon measurement of the gas-phase current of a particular analyte (generally at the mass spectrometer; such as signals shown in FIGS. 5(a), (b) and (c) which show the relative abundances of various species observed in the gas-phase from an electrospray device), a force, such as providable from a conventional air pump, can be applied to a compressible material, such as a gasket material as noted above, to change the gas phase current:

> The electrospray device 100 can be configured to permit at least one dimension of flow channel 125 to be modifiable by application of at least one external force. For example, the electrode chamber 110 can include compressible material. If the material used to form electrode chamber 110 responds to electric and/or magnetic fields, dimensions of flow channel 125 may also be altered through use of electromagnetic forces, rather than mechanical force as in the case of a compressive force.
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> For example, provided electrode chamber 110 includes a compressible material, the channel height 108 can be modified through application of a force, such as a compressive force, applied to electrode chamber 110. The electrospray device 100 can further include a feedback and control system, the feedback and control system for adjustable application of force to the electrode chamber. The magnitude of the force applied can be based on at least one measurement derived from fluid transmitted from the electrode chamber 110, such as the gas-phase current of a particular analyte.

In view of the above, Applicant submits that the 35 U.S.C. §112, first paragraph rejection of claim 9 should be removed.

Claims 23 and 35 were rejected under 35 U.S.C. §112, first paragraph. Claims 23 and 35 recite a switching network for switching connection to a high voltage power supply between respective electrodes. Applicant respectfully disagrees with the Examiner's rejection of claims 23 and 35 under 35 U.S.C. §112, first paragraph since switching networks were known at the time of the invention and many years before by those having ordinary skill in the art of

analytical chemical instruments. This is evidenced by the fact that most commercially available analytical chemical instruments have included switching networks for years.

Also relevant to this issue are multi-electrode cells and potentiostats used in traditional electrochemical systems. One clear example is the Coulochem detector from ESA Inc. Chelmsford, MA. A description of this device can be found on their website http://www.esainc.com/. The specs for the instrument tell of the computer controlled potential settings among the various electrodes.

Thus, together with a suitable feedback and control system, the switching can clearly be dynamic as recited in claim 35, such as on the basis of a measured analyte of a particular species current at a mass spectrometer (see again FIG. 5(a)-(c)).

Claims 37-40 were rejected under 35 U.S.C. §112, first paragraph. Claim 37 recites the step of dynamically changing at least one dimension of the flow channel. Clam 38 recites the dimension including the channel height. Claim 39 recites the dynamic changing is responsive to at least one measured parameter relating to fluid. Finally, claim 40 recites the dynamic changing step comprises altering a force applied to the electrode chamber, wherein the channel height is modified. Based on the discussion above, Applicant submits that claims 37-40 satisfy 35 U.S.C. §112, first paragraph since dynamically changing chamber dimensions is clearly enabled by the specification.

Claims 7-9, and 37-40 were rejected under 35 U.S.C. §112, second paragraph, "as being incomplete for omitting essential elements, such omission amounting to a gap between the elements". According to the Examiner, the "omitted elements are: the means for causing a physical modification of the flow channel and fluid height and the method step of actuating a means for".

Claims 7 and 8 have been left unchanged as they do not recite modifying any chamber dimension, only that the chamber has at least one modifiable dimension. Claim 9 which does recite a feedback and control system has been amended to now recite structure for physically modifying at least one dimension of said flow channel (e.g. such as an air pump) to overcome the gap between the elements asserted by the Examiner.

Regarding claims 37-40, Applicant respectfully disagrees that these claims can reasonably be considered to be incomplete because they lack essential elements. These claims are drawn to a method. Method claims properly include steps, but do not require the recitation of structure. Applicant has researched the issue regarding whether method claims are required to any recite structural details. A CAFC case decided in 1999 clearly answers this question in the negative. (AT&T Corp. v. Excel Communications, 172 F.3d 1352, 1356 (Fed. Cir. 1999); 50 USPQ.2d 1429). Especially note the 7th paragraph in C. where in the last sentence of that paragraph it is stated "Since the claims at issue in this case are directed to a process in the first instance, a structural inquiry is unnecessary". Accordingly, Applicant submits that claim 37-40 satisfy MPEP 2172.01.

Claims 15, 16, 20, and 41 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Regarding claim 15, Applicant has corrected the dependency of claim 15 by amending claim 15 to now properly depend on claim 14 which provides antecedent basis for the electrode support recited in claim 15.

Regarding claims 16, 20 and 41, the Examiner determined that such claims are omnibus claims. Applicant respectfully disagrees, and has copied MPEP 2173.05(r) entitled "Omnibus Claim" for convenient reference to demonstrate this point:

2173.05(r) Omnibus Claim
Some applications are filed with an omnibus claim which reads as follows: A device substantially as shown and described. This claim should be rejected under 35 U.S.C. 112, second paragraph because it is indefinite in that it fails to point out what is included or excluded by the claim language. See Ex parte Fressola, 27 USPQ2d 1608 (Bd. Pat. App. & Inter. 1993), for a discussion of the history of omnibus claims and an explanation of why omnibus claims do not comply with the requirements of 35 U.S.C. 112, second paragraph.

Claims 16, 20 and 41 do not a recite " A device substantially as shown and described' or anything close to such a claim construction. Rather, claims 16, 20 and 41 are examples of proper Markush-type claims, which are not indefinite according to MPEP 2173.05(h) entitled "Alternative Limitations" as these claims do not create any uncertainty or ambiguity with respect to the question of scope or clarity of the claims. According to MPEP 2173.05(h) "The use of Markush claims of diminishing scope should not, in itself, be considered a sufficient basis for objection to or rejection of claims". In the case of claim 16, for example, the electrodes have different properties, the different properties being electrochemical potentials, kinetic properties or catalytic properties. In view of the above, Applicant submits that claims 16, 20 and 41 are clear and satisfy 35 U.S.C. §112, second paragraph.

Now turning to rejections based on cited art, claims 1-6, 14, 17-19, 21, 26-34, and 36 were rejected as being anticipated by U.S. Patent No. 4,885,076 to Smith. Claims 10-12, 24 and 25 were rejected under 35 U.S.C. 103(a) as being unpatentable over Smith, combined with knowledge according to the Examiner "possessed by one having ordinary skill in the art".

Before reviewing the claim rejections based on Smith, Applicant will first review the claimed invention as now claimed in amended claim 1. Amended claim 1 recites an electrospray device comprising a high voltage electrode chamber including a flow channel defined by an inner surface of the chamber, the flow channel comprising an inlet for receiving an analyte

containing fluid to be ionized and an outlet for transmitting the fluid out from the chamber. At least one electrode is provided having an exposed surface to the fluid. The electrode is removably secured to a spaced apart capping member which together define a flow channel height over the electrode which electrolytically produces ions from the fluid. A length of the flow channel over the electrode is greater than the height of the flow channel.

Regarding the removably secured chamber arrangement, such as available from use of turn screw fasteners, the electrode area, electrode material, and solution flow path height over the electrode can be conveniently modified or this feature utilized to facilitate cleaning. Conventional metal capillary-based electrospray sources include a unitary capillary tube for the analyte comprising fluid to pass, such as capillary 20 disclosed by Smith, and thus cannot provide this desirable flexibility.

The short mass transport distance for the analyte to the surface of working electrode improves the electrolysis efficiency compared to convention electrospray emitters. For maximum theoretical electrolysis efficiency to occur, all analyte species must contact the working electrode surface. Efficient analyte electrolysis can be used to increase analyte signal intensity through enhanced electrochemical ionization, to study analyte electrochemistry properties, or to create novel types of gas-phase molecular ions with the ES ion source.

The invention provides substantial control over many of the significant parameters which affect the electrochemistry that occurs at the working electrode in an electrospray device. Parametric control of electrospray factors at and near the working electrode can materially affect the electrochemistry of an electrospray process and permit a system to maximize or minimize certain reactions. Thus, a system can be configured according to the invention to

provide, eliminate or otherwise change, the concentration of one or more particular species in solution for analytical benefit. Applied to mass spectrometry, ions observed in the mass spectrum and their relative intensities can be influenced and controlled in a manner not possible with the limited control over the electrochemistry provided by conventional electrospray designs.

For example, the ability to change the electrode material in a given system provides new system capabilities, such as the ability to supply ions to solution through oxidative corrosion of the electrode material. Metals can be used to form metal-analyte complexes for fundamental study or to improve detection of the targeted analytes. This aspect was discovered when the metal used as the electrode was changed from conventional stainless steel to more easily corroded metals.

Smith is the primary reference cited by the Examiner. Smith discloses a system and method for analyzing molecular constituents of a composition sample. The method includes forming a solution of the sample, separating the solution by capillary electrophoresis into an eluent of constituents longitudinally separated according to their relative electrophoretic mobilities, electrospraying the eluent to form a charged spray in which the molecular constituents have a temporal distribution, and detecting or collecting the separated constituents in accordance with the temporal distribution in the spray. A first high-voltage (e.g., 5-100 KVDC) is applied to the solution. The spray is charged by applying a second high voltage (e.g., .+-.2-8 KVDC) between the eluent at the capillary exit and a cathode spaced in front of the exit. A complete electrical circuit is formed by a conductor which directly contacts the eluent at

the capillary exit, or by conduction through a sheath electrode discharged in an annular sheath flow about the capillary exit.

Figure 13 of Smith is used by the Examiner in the Office Action. Figure 13 shows a device which includes two electrodes, one (ref 40) coating the inside of capillary 20 and a metal capillary identified as electrode 120 that has an inner diameter greater than the outer diameter of capillary 20. The two cocentric tubes form an annular sheath 125 there between to flow a non-analyte containing "make-up" liquid. Coating/electrode 40 is described as generally being sputtered on (col. 6, line 65-66), thus being in intimate contact with unitary capillary 20. Electrode 40 is clearly not detachable from capillary 20. Electrode 40 extends to the exit end of capillary 20.

Although electrode 120 can be slid with respect to coated inner capillary 40/20, the analyte solution only flows through a single non detachable metal coated capillary 40/20. Thus, although two electrodes are shown by Smith, only one contacts the analyte containing fluid and can function as a working electrode to generate ions.

In contrast to Smith, Applicant's claimed system includes an electrode having an exposed surface to the analyte containing fluid, "said electrode removably secured to a spaced apart capping member which together define a flow channel height over said electrode". As noted above, Smith's electrode 40 is intimately attached to capillary 20 which together define a flow channel height over the working electrode 40. Thus, electrode 40 is clearly not "removably secured to a spaced apart capping member which together define a flow channel height over said electrode".

Because of Applicant's removably secured chamber arrangement, such as available from the use of the disclosed turn screw fasteners, the electrode area, electrode material, and solution flow path height over the electrode can be conveniently modified, or utilized to facilitate cleaning. Smith's unitary capillary tube design for the analyte comprising fluid to pass (40/20) cannot provide this highly desirable flexibility provided by Applicant's readily modifiable chamber design. Accordingly, Applicant submits that amended claim 1 and all claims dependent thereon are patentable over Smith.

Several dependent claims are believed to provide separately patentable subject matter. Claim 3 recites the working electrode is remotely located from the outlet of the chamber. With this arrangement as opposed to conventional metal capillary electrodes such as Smith (ref 40) which are held at high field, the likelihood of a corona discharge at the tip of spray capillary is minimized. The liquid from the spray tip to the electrode acts as a limiting resistor in the series electrochemical circuit formed, and thus, as a discharge suppressor.

Claims 7 and 8 recite modifiable chamber dimensions. Claim 9 recites a feedback can control system and structure for physically modifying at least one dimension of the flow channel. As noted above, Smith's coated capillary does not provide any of these claimed features.

Regarding claim 15, this claim now recites two electrodes which both contact the analyte containing fluid and are thus both working electrodes. Although Smith discloses two electrodes, only one contacts the analyte containing fluid. Regarding claims 24 and 25 which recite a planar electrode, and planar electrode support and capping member, respectively, are

believed to add further patentable features. The working electrode being substantially planar limits flow resistance and void volume. Applicant respectfully disagrees with the Examiner that:

> it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the shape of the electrodes of Smith et al. because it has been held that a modification of an essential elements shape is an obvious step so long as no new and unexpected result is achieved by such a modification.

Importantly, Smith's device is based on capillary tubes which are inherently curved. Electrode 40 coats the entire circumference of capillary 20, and is thus clearly not planar. The feature referred to by the Examiner in Smith as the capping member 50 is removed from the analyte solution is clearly distinct from Applicant's claimed capping member which together with the electrode define a flow channel height over the electrode. "Capping member" 50 is described in col. 6, lines 59-64 by Smith as a layer "plated cocentrically about the exit of the outlet end 40".

Applicant's planar arrangement provides new and unexpected results. For example, the planar arrangement provides a relatively large cross sectional flow channel area with a minimum of flow resistance, yet still provides a very thin channel. A 10 micron tube 2 cm long typical of the related art is extremely easy to plug. The narrow (e.g. 10 micron high) and wide (e.g. 1 cm) channel together with a planar electrode is very difficult to plug and offers little flow resistance (backpressure).

The relatively large cross sectional flow channel area provides reasonable high fluid flow rates while the thin channel provides high electrochemical efficiency unavailable from conventional circular geometries. High flow rates provide efficient oxidation/reduction with minimum time of the analyte in the cell. Used together with a mass spectrometer, this provides a fast response time for the mass spectrometer for electrochemical products and also the ability to

preserve short lived species that are otherwise lost through homogeneous reactions with solution components. Accordingly, Applicant submits that claims 24 and 25 which recite a planar electrode, and planar electrode support and capping member, add further patentable features.

Claim 30 which recites a mass spectrometer and claim 33 which recites a method of producing charged droplets have been amended to now recite the patentable electrode chamber features recited in amended claim 1 as noted above. Claim 33 adds the steps of disassembling the chamber, and changing at least one of the electrode, the capping member, or a structure between the electrode and the capping member, and returning the chamber to service. Accordingly, Applicant submits that amended claims 30 and 33 and all claims dependent thereon are patentable over Smith.

Applicants have made every effort to present claims which distinguish over the prior art, and it is believed that all claims are in condition for allowance. However, Applicants invite the Examiner to call the undersigned if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance.

No fees are believed due with the filing of the above Reply. However, the Commissioner for Patents is hereby authorized to charge any deficiency in any fees due with the filing of this paper or during prosecution of this application to Deposit Account No. 50-0951.

Respectfully submitted,

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